AG Contract No. KR03-0178TRN
ADOT ECS File No. JPA 02-209
Project No. SPR 557 – TRACS R0557 15P
Section: Northern Arizona University
Railroad-Highway Crossing Cooperative Signal
Research Project

INTERGOVERNMENTAL AGREEMENT

BETWEEN
THE STATE OF ARIZONA
AND
NORTHERN ARIZONA UNIVERSITY

THIS AGREEMENT is entered into 14 March, 2003, pursuant to Arizona Revised Statutes, Sections 11-951 through 11-954, as amended, between the STATE OF ARIZONA, acting by and through its DEPARTMENT OF TRANSPORTATION (the "State") and the ARIZONA BOARD OF REGENTS, acting for and on behalf of NORTHERN ARIZONA UNIVERSITY, (the "University").

I. RECITALS

1. The State is empowered by Arizona Revised Statutes Section 28-401 to enter into this agreement and has delegated to the undersigned the authority to execute this agreement on behalf of the State.

2. The University is empowered by Arizona Revised Statutes Section 15-1626 to enter into this agreement and has authorized the undersigned to execute this agreement on behalf of the University.

3. The State and the University desire to participate in the Railroad-Highway Crossing Cooperative Signal Control Research Project-SPR-557, hereinafter referred to as the Project, as a part of University's continued work at the AZTrans Center in advanced traffic signal control algorithms. The project will functionally coordinate long-range train detection data with traffic signal timing adjustments, to improve traffic flow and safety, and to minimize congestion, for the safety and benefit of the traveling public. The duration of the project will be approximately eighteen months, at an total program cost of $219,500.00. The parties hereto agree the University shall be the lead agency for the Project.

THEREFORE, in consideration of the mutual covenants expressed herein, it is agreed as follows:

NO. 25886
Filed with the Secretary of State
Date Filed: 03/14/03
Janice K. Brewer
Secretary of State
By: Amy V. Thuesewald

II. SCOPE OF WORK

1. The University will:

a. Conduct appropriate research at the AZTrans Center in advanced traffic signal control algorithms. Prepare final reports and submit them to State's Transportation Research Center. Incorporate or resolve State review comments.

b. Be responsible for an amount estimated at $31,500.00 for the cost of the Project as shown on Exhibit B.

c. Appoint a Project coordinator at the University to interface with the State relating to the research and development.

d. Accomplish the research and development in accordance with Exhibit A, which is attached hereto and made a part hereof. A final report documenting the program, data derived, and the final results will be prepared and submitted. Such reports will be in a format compliant with State's "Guidelines for Preparing Research Reports". Incorporate or resolve State review comments.

e. No more often than monthly, invoice the State in the form of Exhibit C attached hereto, supported by narrative reports and an accounting of monthly costs and expenditures on the Project. Upon completion of the Project, provide the State with a detailed final report.

2. The State will:

a. Incorporate or resolve University review comments.

b. Reimburse the University after receipt and approval of monthly invoices, in a total amount not to exceed $155,000.00.

c. Appoint a Project coordinator to interface with the University relating to the research and development.

III. MISCELLANEOUS PROVISIONS

1. This agreement shall become effective upon filing with the Secretary of State.

2. This agreement shall remain in force and effect until completion of said project and reimbursements; provided, however, that this agreement, may be cancelled at any time prior to the commencement of performance under this contract, upon thirty (30) days written notice to the other party.

3. This agreement may be cancelled in accordance with Arizona Revised Statutes Section 38-511.

4. The provisions of Arizona Revised Statutes Section 35-214 are applicable to this contract.

5. In the event of any controversy, which may arise out of this agreement, the parties hereto agree to abide by required arbitration as is set forth for public works contracts in Arizona Revised Statutes Section 12-1518.

6. All notices or demands upon any party to this agreement shall be in writing and shall be delivered in person or sent by mail addressed as follows:

Arizona Department of Transportation
Joint Project Administration
205 South 17 Avenue, Mail Drop 616E
Phoenix, Arizona 85007
FAX (602-712-7424

Craig Roberts, NAU Technical Contact
Director of AZ Trans
College of Engineering & Technology
Northern Arizona University
P. O. Box 15600
Flagstaff, Arizona 86011

Koleen Quattlebaum, NAU Administrative Contact
Office of Grant and Contract Services
Babbitt Administrative Center
Northern Arizona University
P.O. Box 4130
Flagstaff, Arizona 4130

7. Attached hereto and incorporated herein is the written determination of each party's legal counsel that the parties are authorized under the laws of this state to enter into this agreement and that the agreement is in proper form.

IN WITNESS WHEREOF, the parties have executed this agreement the day and year first above written.

ARIZONA BOARD OF REGENTS
For and on behalf of
Northern Arizona University

By Wilma G Ennenga 2/21/2003
Wilma G. Ennenga
Director, Office of Grant and Contract Services

STATE OF ARIZONA
Department of Transportation

By Debra Brisk
DEBRA BRISK
Deputy Director

G: 02-207-Atlas 4-Railroad/Highway Crossing Project
30Jan2003-jw

Dated 12/08/02

Arizona Department of Transportation
Congestion-Mobility Management:
Railroad/Highway Crossing Cooperative Signal Control

Project 557, FY 2003
Research Program Workscope

Date: 12/08/02

A - Research Problem Statement

Railroad grade crossings create traffic control problems that severely impact traffic flow. Safety problems occur in urban areas where a street that feeds into an arterial has a grade crossing near that intersection. Here, the left and right-turn arterial stacking lanes may overflow onto the arterial mainline as a passing train blocks the minor street. At Flagstaff, for example, this condition exists on SR 89 at the Enterprise Road intersection, with 85 trains per day. Smaller towns as well as larger cities have these problems and both the Pima and Maricopa metropolitan regions recognize the issues and support the search for better remedies.

Similar safety problems occur in semi-rural areas where the grade crossings for feeder roads at Freeway Traffic Interchanges (TIs) lead to long blockages of peak hour traffic movement, causing severe congestion. Even worse, overflows of queued vehicles onto the freeway mainline can occur as ramp-stacking capacity is exceeded. A prime example is the I-10 / Cortaro Road TI on the north side of the Tucson Metro Area, with 85 trains per day. Several other TI locations on Interstate 10 in this area have similar problems.

In many of these cases, where highways and railroads are parallel, ADOT manages the affected traffic signals. ADOT currently has approximately 30 traffic signals with train preemption. Growth in both train traffic and vehicular traffic is predicted, as Arizona's population continues to increase. The safety and congestion problems caused by preemption at-grade RR/Highway crossings are forecast to spread to more ADOT sites statewide.

B - Research Team

The research team for this Research Project is AZ*Trans*: The Arizona Laboratory for Applied Transportation Research (hereinafter called AZ*Trans*), a part of the Department of Civil and Environmental Engineering, College of Engineering and Technology, Northern Arizona University (hereinafter called NAU). The team is lead by the Principal Investigator (hereinafter called the "P.I."), Craig A. Roberts, Ph.D., P.E., Director of AZ*Trans* and a NAU Assistant Professor. Other NAU research engineers and technicians, faculty, and students will work on the project as deemed appropriate by the P.I. Consultants and service providers will be used for some tasks, as detailed in this workscope.

C - Research Goal

This research project's goal is to attempt to develop site-specific, enhanced train clearance algorithms that can provide significantly more green time to key traffic movements, before the arrival of a train at an at-grade RR/Highway crossing. The posited result will be the reduction of traffic overflows and congestion typically caused at the site by the train's preemption of normal

traffic signal operation. This traffic control scheme is called "railroad/highway crossing cooperative signal control." The research goal contains two primary research objectives:

Research Objective 1 - Predict Train Arrivals and Durations at Site:

ITS detectors can monitor train speed, acceleration, deceleration, and length far in advance of current systems that give a minimum 20 seconds of warning time. This ITS data can be used to develop site-specific prediction models of train arrival times and crossing durations.

Research Objective 2 - Reduce Congestion Caused by Train Preemptions:

Assuming Objective 1 is met, the site-specific prediction model, operating in real-time, can provide very early predictions of train arrival times and durations to intersection signal controllers at and near the RR/Highway crossing site. This prediction information can be used to modify traffic controller movement timings before and after the predicted train passage. The objective is to develop modified movement timings that will reduce traffic congestion when compared to the traffic flows resulting from the existing preemption traffic controller operations. An additional tool that could be used is Dynamic Message Signs (hereinafter called DMS).

D - Expected Benefits of Implementation

The only effective solution currently available to address the research problem is grade separations, for which the need and the cost far outstrip ADOT's ability to build them. The intended result of this applied research is to provide a tested prototype congestion-mobility management tool that can be used to reduce congestion at RR/Highway crossings that fit the research problem characteristics. The number of such RR/Highway crossings will increase, as population growth continues in Arizona.

This research project will benefit both the public and ADOT with regard to safety and to congestion-mobility management. Assuming future phases of this research provide successful field deployments of the prototype developed in this research project, benefits of this research will include:

1. Saving lives at-grade crossings by reducing the delay and the temptation to run the gates.
2. Reducing the potential for rear-end collisions caused when queues from blocked at-grade crossings back up into the mainline freeway lanes and/or arterial through-lanes.
3. Reducing traffic delays and congestion. Delay and congestion typically degrade regional air quality.
4. Providing valuable delay inputs to Advanced Traffic Management Centers and Traveler Information Systems in the area.

E - Research Program Tasks

The research program designed to accomplish the project goal will extend over 18 months. The research goal is divided into two research objectives, as described previously, and is further subdivided into several research tasks listed in Attachment A. These tasks apply to the site located in the City of Flagstaff. Through a separate agreement from this JPA, the City of Flagstaff is also a Funding Partner of this research program in addition to ADOT.

New tasks may emerge during the progression of the research as unforeseen problems arise. The time and resource estimates for these tasks will shift as the research is accomplished, some taking less and others taking more than estimated.

It is important to note that research, by its very nature, explores the unknown. There are no "similar" projects that can be used as a basis to estimate the time and resource budgets needed to accomplish this research program.

The allocations of time and resources to various tasks in this research project are estimates. The P.I. may reallocate time and/or dollar amounts to better progress the work at any time based on his sole discretion. The total research project time and dollar resource amounts are fixed and require the mutual approval of the parties to modify, unless stated otherwise in the contracts among the parties.

During the life of the contract, additional sites may be added. Each new site will be funded by a new Funding Partner, i.e., partners other than ADOT or the City of Flagstaff, and will be added by separate agreements with NAU. If these occur, addendums will be added to this JPA to document any changes they may have on this JPA's scope and schedule. It is currently anticipated that new sites and funding partners may be added in Pima and Maricopa counties.

F - Other Items

Consultants and service providers may be used for portions of the work as deemed advisable by the P.I. It is anticipated that a service provider will be used to collect traffic data at the Flagstaff site, perhaps on more than one occasion. Also, one or more consultants from the Texas Transportation Institute may be used from time to time on matters for which they are known to be experienced. These include the TDUs, CPU, the microsimulation traffic computer model, hardware-in-the-loop methods, and RR operations. The P.I. may use these or other consultants and/or service providers for additional tasks to better progress the work at any time based on his sole discretion.

G - Services and Equipment Supplied by the Funding Partners

All parties agree that it is critical to the research project that certain services and equipment be provided to the Research Team by the Funding Partners in a manner timely to the progression of the research work. These have been specified in Attachment B. It is further agreed that if additional services and/or equipment is identified during the progression of the work that is of a similar nature to that specified in Attachment B, the Funding Partners will make every effort to also provide these.

H - Technical Advisory Committee (TAC)

Pending:

ADOT Sections

ADOT Districts

Partner Cities

Attachment A

Research Program Tasks

Based on discussions with ADOT and the City of Flagstaff traffic personnel, the Flagstaff site will consist of a single RR/Highway crossing and a single roadway signalized intersection. The RR/Highway crossing is on Enterprise Road, just south of Santa Fe Avenue (East Route 66). The signalized intersection is Santa Fe Avenue (East Route 66) at Enterprise Road. The tasks designed to accomplish the research project goal at the Flagstaff site are as follows:

Task 1 Review work by others that may be useful to this research.

Task 2 Acquire major equipment and train AZ*Trans* personnel on its use.

Task 3 Collect data at Flagstaff Site.

Task 4 Develop Site-Specific Train Prediction Model for Flagstaff Site.

Task 5 Develop a microsimulation traffic computer model of Flagstaff site.

Task 6 Incorporate vehicle traffic controllers into the microsimulation model using hardware-in-the-loop techniques for the Flagstaff site.

Task 7 Develop alternative signal timing schemes that use early train arrival/duration prediction to reduce congestion at the Flagstaff site.

Task 8 Conduct sensitivity testing for the impacts of prediction errors at the Flagstaff site.

Task 9 Provide program administration, progress reports and final project deliverables according to the ADOT-ATRC Guidelines. Pursue any and all technology transfer opportunities.

Attachment B

Services and Equipment Supplied by the Funding Partners

The Funding Partners agree to provide these services and equipment to the Project Team in a manner timely to allow the smooth progression of the research work.

ADOT Provided Services and Equipment

1. Provide scaled aerial photos and as-built drawings of the site, if available, and assist in collecting supplemental topographic survey data at site, as needed.
2. Assist in any permitting, as required, that is needed for all fieldwork.
3. Provide existing traffic counts in the area of the site.
4. Assist, as applicable, in new traffic counts taken at each site, i.e., loan of traffic counting equipment, loan of two-way radios, providing technician help, as available, in taking counts etc.
5. Install Train Detector Units (TDUs) on existing ADOT poles or on other utility poles, if agreeable to utilities. If no pole exists, install a pole (3 to 6 poles per site) in sponsor right-of-way (R/W). Help seek R/W permission from other governmental units for TDU pole locations, as required.
6. Provide two traffic controllers identical to one used at site or, if needed, units with more capability.
7. Provide and install a controller cabinet near the existing cabinet to house research equipment under secure conditions. Assist in installing research equipment in this cabinet and making connections to the existing cabinet for data acquisition and power, as required.

City of Flagstaff Provided Services and Equipment

1. Provide scaled aerial photos and as-built drawings of the site, if available, and assist in collecting supplemental topographic survey data at site, as needed.
2. Assist in any permitting, as required, that is needed for all fieldwork.
3. Provide existing traffic counts in the area of the site.
4. Assist, as applicable, in new traffic counts taken at each site, i.e., loan of traffic counting equipment, loan of two-way radios, providing technician help, as available, in taking counts, etc.
5. Assist in installing Train Detector Units (TDUs) and/or moving them to other pole locations. Help seek R/W permission from other governmental units for TDU pole locations, as required.
6. Assist in installing research equipment in ADOT provided controller cabinet and making connections to the existing cabinet for data acquisition and power, as required.

EXHIBIT B

Dated 12/08/02

ADOT Congestion-Mobility Management:Railroad/Highway Crossing Cooperative Signal Control Research Program Estimated Budget

Project 557, FY 2003 P.I.: Craig A. Roberts, Ph.D., P.E.			FUNDING PARTNER ADOT		FUNDING PARTNER City of Flagstaff		NAU CONTRIBUTION Equip. Contribution	
	units	unit price	units	extension	units	extension	units	extension
Labor and Benefits								
Salary or Wages								
Principal Investigator	month	7,000	2	14,000	0.5	3,500		
Grade 1 Research Engineer	month	3,200	13	41,600	1.5	4,800		
Undergraduate Students	hour	10	750	7,500	310	3,100		
Graduate Students	hour	15	350	5,250	100	1,500		
Subtotal Salaries or Wages				*68,350*		*12,900*		
Fringe Benefits on Salary and Wages								
Principal Investigator	multiplier	0.50	na	7,000	na	1,750		
Grade 1 Research Engineer	multiplier	0.40	na	16,640	na	1,920		
Undergraduate Students	multiplier	0.01	na	75	na	31		
Graduate Students	multiplier	0.01	na	53	na	15		
Subtotal Fringe Benefits on Salaries & Wages				*23,768*		*3,716*		
Subtotal Labor and Benefits				***92,118***		***16,616***		
Equipment								
Traffic Data Collection Equipment (rent rest)	each	2,500			2	5,000		
Train Detector Units (TDUs) (sensor, processor, solar, wireless communication, box but no pole)	each	3,000	6	18,000			1	
Mobile Remote-Sensing Trailer (self-contained 2-wheel trailer with all equip and extending pole--wired for multiple sensor heads including radar and video)	L.S	25,000					1	25,000
Hardware-in-loop interfaces (CIDs)	each	3,000	1	3,000			1	3,000
Misc Electronics to adapt CID for radar sensor inputs	L.S	1,000	1	1,000				
Misc cable, electronics, bench-scale pieces, etc	L.S	1,000	1	1,000				
Dedicated field computer (laptop)	each	3,500					1	3,500
Simulation, Coordination, and Video-count Softwares	L.S	5,500	1	5,500				
Subtotal Equipment				***28,500***		***5,000***		***31,500***
Travel								
Visit TTI & similar site	per person	750	2	1,500				
General Site visits throughout life of the project, e.g., to collect data, etc. Assume typical visit is 2 days by 2-person teams								
Site visits--Flagstaff	per person	50			4	200		
Site visits--Phoenix (potential future site)	per person	400						
Site visits--Tucson (potential future site)	per person	400						
Present paper at TRB (P.I., and one student)	each	1000	2	2,000				
Subtotal Travel				***3,500***		***200***		
Other								
Collect Traffic Data for 4 days per site	each	5000			1	5,000		
TTI researcher(s) for trouble-shooting backup	L.S	5000	1	5,000				
Subtotal Other				***5000***		***5000***		
Subtotal All Costs				***129,118***		***26,816***		***31,500***
NAU's Indirect Costs	multiplier	varies		*25,824*		*6,166*		
Estimated Total All Costs				***$154,941***		***$32,982***		***$31,500***
Total All Costs (Partner Contributions)				$155,000		$33,000		$31,500
Items Provided by Funding Partners In addition to the funding here, the Funding Partners agree to provide to the Project Team the services and equipment detailed in the agreement in a manner timely to allow the smooth progression of the research work.				ADOT		City of Flagstaff		

Sum of Total Estimated Costs = *$219,423*

Sum of All Partner Commitments = *$219,500*

Note: Additional sites may be created during the project with new funding partners, under separate agreements with NAU. If so, amendments to this JPA will document any changes to the program scope and budget.

EXHIBIT C

ARIZONA DEPARTMENT OF TRANSPORTATION
PROGRESS PAYMENT REPORT

		Progress:			Final:	
Report No.						

Project No.	Date Ending:
TRACS No.	
Name of Project	
Vendor/Customer	
REMIT TO:	

Date Started	Estimated Completion Date:	% Billed	% Complete

SUMMARY OF WORK FOR WHICH PAYMENT IS REQUESTED

ITEMS	DESCRIPTION	CONTRACT NTE	Previous Accumulative Amount	Current Month	Accumulative Amount

Submitted By: _____	Date: _____	Total To Date:
Approved By: _____ ADOT Project Manager	Date: _____	Total Previous Report:
Approved By: _____ Joint Project Administration	Date: _____	Current Report:

CONMASTR/PRFORMAT

APPROVAL AS TO FORM

Dated the 20th day of February, 2003

Arizona Board of Regents
for and on behalf of
Northern Arizona University

By: _____
Dean Pickett, Attorney at Law

And

Arizona Department of Transportation

By: _____

TERRY GODDARD
ATTORNEY GENERAL

OFFICE OF THE ATTORNEY GENERAL
STATE OF ARIZONA

CIVIL DIVISION
TRANSPORTATION SECTION
WRITER'S DIRECT LINE: 602.542.8855

INTERGOVERNMENTAL AGREEMENT
DETERMINATION

A.G. Contract No. KR03-0178TRN (JPA 02-209), an Agreement between public agencies, has been reviewed pursuant to A.R.S. § 11-952, as amended, by the Undersigned Assistant Attorney General who has determined that it is in the proper form and is within the powers and authority granted to the State of Arizona.

No opinion is expressed as to the authority of the remaining Parties, other than the State or its agencies, to enter into said Agreement.

DATED March 6, 2003.

TERRY GODDARD
Attorney General

Susan Davis

SUSAN E. DAVIS
Assistant Attorney General
Transportation Section

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att.